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THE EFFECTS OF TEMPO AND INTENSITY
ON HYPERACTIVE CHILDREN

Storne L. Shively

Department of Psychology

Ph.D. Degree, July 1984

Abstract

This study examined the cognitive and behavioral effects of auditory stimulation on hyperactive children. Thirty-two male Caucasian boys, ranging in age from six to fourteen were randomly assigned to one of four treatment conditions. Treatment conditions consisted of listening to music that varied according to intensity (high and low) and tempo (fast and slow). The four combinations of music were high and fast, high and slow, low and fast, and low and slow. The subjects performed a cognitive task during the assigned treatment condition and also during a no-music condition. Behavioral observations and ratings were also taken during these conditions in the early part of the study. Analysis of variance showed no significant differences in either the music/no-music conditions or as a result of the specific variables of tempo and intensity. Results of the study do not support the underarousal theory as an explanation for hyperactivity or the stimulation approach as a viable treatment technique.

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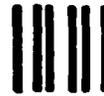
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THE EFFECTS OF MUSICAL TEMPO AND INTENSITY
ON HYPERACTIVE CHILDREN

A Dissertation
Presented to the
Department of Psychology
Brigham Young University

In Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

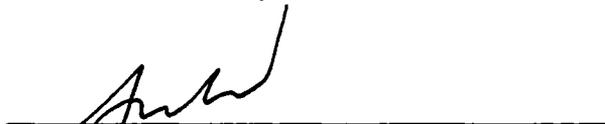
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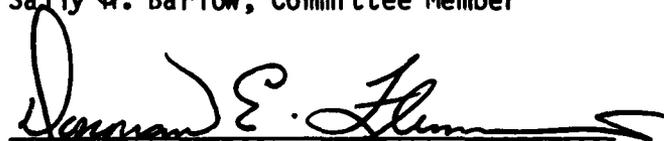
This dissertation, by Storne L. Shively, is accepted in its present form by the Department of Psychology of Brigham Young University as satisfying the dissertation requirement for the degree of Doctor of Philosophy.


I. Reed Payne, Committee Chairman


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7 August 1984
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Donovan E. Fleming, Department Chairman

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This is lovingly dedicated

to

my family.

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CHAPTER 1

Introduction

It has been estimated that as many as 40% of the school age children referred to mental health clinics and 19% of all elementary school children could be labeled hyperactive (Zentall, 1975). General surveys suggest that 5-6% of school age children are considered by parents, teachers, and their family doctors to be hyperactive. Depending on the strictness of definition and criteria, it has been suggested that hyperactivity potentially affects as many as 2.5 million 5-14 year-olds or as many as 1 in 20 children of this age group in the U.S. (Weiner, 1982).

Although the treatment of choice for hyperactivity has been amphetamines, their side effects cause enough concern that other alternatives to drug therapy have been sought. One such alternative--the use of environmental stimulation to treat hyperactivity--arises out of recent proposals that hyperactivity may reflect an underaroused nervous system (Zentall, 1975; Rosenthal, 1973; Satterfield, 1975). Hyperactive behaviors are seen as the individual's attempt to bring his or her stimulation up to an optimum level. Hyperactive behaviors, however, are disruptive and an inefficient way to increase stimulation (Koester & Farley, 1981). There is recent evidence that increasing environmental stimulation through visual or auditory means reduces the need for hyperactive

behaviors. Some past as well as recent studies have shown a reduction in hyperactive behaviors and an increase in cognitive performance as a consequence of increased auditory and/or visual stimulation (Carter & Diaz, 1971; Zentall & Zentall, 1976; Scott, 1970; Reardon & Bell, 1970; Zentall, 1980; Gardner & Cromwell, 1959; Forehand & Baumeister, 1970; Spraudlin & Cromwell, 1969).

Many of these studies suffer from poor methodology and the lack of statistical controls. The present experimental study attempted to improve research in this area by using a larger sample size than many of these studies, more carefully controlling for variables such as order of treatment conditions and dependant variables through randomization, using appropriate statistical techniques such as analysis of variance and by exploring some specific variables that might be operative in auditory stimulation with hyperactive children. Having subjects perform cognitive tasks under music and no-music conditions, the experiment attempted to study the effect of some specific variables of music, such as intensity (loudness) and tempo. Previous research had not investigated these variables and yet there was reason to believe that they were important (Radocy & Boyle, 1979). The expectation was that not only would certain music produce beneficial results (i.e., reduction in hyperactive behavior and improvement in cognitive performance), but that a fast tempo and higher intensity would prove more beneficial than a slow tempo and a lower intensity. It was hoped that the results of this study would add to the body of knowledge that might make the use of environmental stimulation of hyperactive children an effective alternative treatment approach in the future.

Literature Review

Although referred to by a variety of names--hyperactivity, hyperkinesis, minimal brain dysfunction (MBD), minimal brain disorder (MBD), attention deficit disorder (ADD) and attention deficit disorder with hyperactivity--researchers have been remarkably consistent in defining the symptom complex--short attention span, increased activity, distractability, impulsiveness, explosiveness, inability to delay gratification, and poor performance despite adequate measured intelligence (Zentall, 1975; Satterfield, Cantwell, Lesser, & Podosin, 1972; Weiner, 1982). In the current Diagnostic and Statistical Manual of Mental Disorders (DSM III), the term "attention deficit disorder with hyperactivity" has been substituted for "hyperactivity". In the interests of simplicity, "hyperactivity" will be used instead of "attention deficit disorder with hyperactivity" or "minimal brain dysfunction" in this paper.

Hyperactivity as a syndrome consists of certain distinctive behavioral and cognitive-perceptual impairments (primary symptoms) which often lead to other social, academic, and emotional problems (secondary symptoms).

The major behavioral symptoms of the hyperactive child are hyperactivity, distractability, impulsivity and excitability. They often exhibit a "driven" quality--seemingly always on the go--restless, fidgety and exhibiting what seems to be purposeless movements that put them in constant contact with their environment. They often appear clumsy, awkward and unable to relax. They seem to have short attention spans and difficulty concentrating. Tasks occupy

them for only a short time when they turn their attention to something else.

Because they are excitable and impulsive, they exhibit poor frustration tolerance and limited self-control. They display temper outbursts, rapid mood changes, negativism and aggressiveness. Although many of these symptoms are normal in childhood, in the hyperactive child, they exist to a greater degree and persist oftentimes into adulthood. Their perceptual-motor problems make them a prime target of ridicule by peers. This, coupled with poor frustration tolerance and excitability, often produce difficulties with peer relations--making the hyperactive child a common discipline problem. Given such behavioral, perceptual-cognitive, academic, social and emotional difficulties, the hyperactive child characteristically develops poor self-esteem. A number of studies confirm that these children are often disliked and rejected by classmates (Bryan, 1978; Bruininks, 1978a, 1978b; Paulankas and Campbell, 1979; Serafica & Harway, 1979). Continuing academic and emotional stress, coupled with such social isolation, often leads such children into anti-social acts such as fighting, stealing, lying and cheating (Cantwell, 1975b; Schecter, 1974).

Although the primary behavioral manifestations of the syndrome tend to diminish during adolescence, many individuals still remain more restless, impulsive, distractable, and excitable than other children. However, in the absence of treatment, the secondary symptoms--such as learning difficulties, poor self-esteem and anti-social acts--often become worse in adolescence (Campbell, 1976; Milich & Loney, 1979; Minde, Weiss & Mendelson, 1972). By adulthood, Weiner

(1982) has stated "an undetermined but probably substantial number of adults who were diagnosed MBD/ADD in childhood will continue to have serious adjustment difficulties and there is reason to believe that the problem of many adults who are thought to have 'impulse disorders' of purely psychological origin may derive in fact from the same causes as the anti-social conduct seen in MBD/ADD children and adolescents (Morisson, 1979; Weiss, Hechtman, Perlman, Hopkins & Wener, 1979; Wood, Reimberr, Wender & Johnson, 1976).

Thus, hyperactivity represents a syndrome of substantial cost, both to the individual who suffers educationally, cognitively, psychologically, socially, and emotionally--and also to the society that suffers through the loss of what could be otherwise beneficial productive members, but who often become instead, marginally functioning individuals, prone to anti-social acts and suffering from depression, minimal self-esteem and social isolation.

Although the etiology of hyperactivity is at this time unknown, it is widely assumed to involve some impairment of the central nervous system. Another common term used--"minimal brain dysfunction," reflects the attitude that has evolved over a number of years to label "children who have no detectable organic pathology but nevertheless display many of the functioning difficulties seen in people with known brain damage" (Weiner, 1982). In fact, many, but not all of these children, display "soft" signs of neurological damage as well as abnormal EEG's (Gardner, 1979; Ingram, 1973; Rie & Rie, 1978; Schain, 1980).

Theories of Hyperactivity

Stimulus reduction model. Educationally, most of the treatment for hyperactivity has followed the theoretical "Stimulus Reduction" model of Strauss and his colleagues (1947) who proposed that hyperactivity was a form of brain damage manifested by an inability to adequately filter or ignore irrelevant stimuli and difficulty organizing relevant stimuli. The inadequate filtering of stimuli was presumed to overload the hyperactive child with stimulation, resulting in hyperactive behavior in response to stimulus overload. A colleague of Strauss, Cruickshank (1961), engineered a reduced stimulus environment in which he tested the behavior of hyperactive children. Although no significant differences in academic gains were found between the experimental and control groups, Cruickshank maintained that his results supported the reduction theory of hyperactivity. The educational system has since popularized and used extensively such reduced stimuli environments in the treatment of hyperactive children. Weiner (1982) has stated that "The wide-spread acceptance of environmental stimulation as a potentiator of hyperactivity is based largely on Cruickshank's inconclusive results."

Underarousal Model

In recent years, however, an alternative theory has been proposed for hyperactivity called the "underarousal theory" (Rosenthal, 1973; Koester & Farley, 1981; Zentall, 1975). It is based on the optimal arousal theory proposed by Leuba (1955). Leuba proposed that all organisms function homeostatically--when overaroused they react to reduce stimuli, and when underaroused, they act to seek stimulation. It has been suggested that instead of being overactive, the nervous

system of hyperactives is underaroused and that the hyperactive behavior functions as an attempt to bring the nervous system up to an optimal level of functioning. Drug therapy, the most effective treatment to date and the primary treatment for hyperactivity (Zentall, 1976), can be viewed as a major source of support for this therapy.

In 1941, Bradley discovered that amphetamines reduced the activity level of hyperactive children producing a general alertness, more focussed attention, improved performance on tests of memory and perceptual-motor coordination, and fewer handwriting problems (Gittelman-Klein & Klein, 1976; Humphries, Swanson, Kinsbourne & Yiu, 1979; Lerer, Artner & Lerer, 1979; Spring, Yellin & Greenber, 1976; Werry, 1975). Dexedrine (dextroamphetamine) and Ritalin (methylphenidate) have become the drugs of choice. They have been shown to have a calming effect on hyperactive children, producing behavior that is less restless with longer attention spans and fewer aggressive outbursts (Barkley, 1979; Henker, Whalen & Collins, 1979; Quinn & Rapoport, 1975; Thurston, Sobol, Swanson & Kinsbourne, 1979). This effect has been called a "paradoxical" effect--that an amphetamine that otherwise "arouses and stimulates" normals would exert a calming effect and reduction in the activity of hyperactive children. According to the underarousal theory, amphetamine action, instead of being "paradoxical," works as would be expected--to increase arousal in an otherwise "underaroused" individual--in this case, hyperactive individuals. The amphetamine actually operates to bring the individual's nervous system up to an optimal level of arousal.

There is growing support and empirical evidence for the "underarousal" theory of hyperactivity. A number of older studies (Gardner & Cromwell, 1959; Reardon & Bell, 1970; Forehand & Baumeister, 1970) concentrated on the effects of stimulation on hyperactive retardates. Gardner and Cromwell found decreased motor activity with increased auditory and visual stimulation. Reardon and Bell (1970) found a reduced activity level as a result of musical stimulation as opposed to a baseline or a non-musical spoken condition. In addition, he found "stimulative" music to be significantly more effective in lowering activity level than "sedative." Finally, Forehand and Baumeister (1970) found increased auditory and visual stimulation to be associated with a reduction in activity level. Decreasing the stimulation was conversely associated with increased activity. No significant differences were found between auditory and visual stimulation.

Most recently, attention has turned to the effects of stimulation on normal I.Q. hyperactive children. Scott (1970) in a study of four hyperactive children, found significant differences in arithmetic performance scores between four conditions (normal classroom, normal classroom with music playing, reduced stimulation booth, and booth with music). The latter three conditions produced marked improvement over the normal classroom setting. Three of the children performed best under the normal classroom with music playing condition--an increased stimulation condition.

Carter & Diaz (1971) in a study of 42 brain injured and 42 controls, found that auditory and visual "distraction" conditions did not result in impaired performance of brain injured children. Their

auditory "distraction" (taped classroom sounds) resembled auditory stimulation in other studies. Zentall (1976) studied the activity level and task performance of hyperactive children as a function of manipulating visual and auditory stimulation. Although they found no academic improvement as a result of high levels of stimulation, they did find activity level to be significantly reduced. More recently, Zentall (1980) studied the behavior of 31 hyperactives and 31 controls in natural settings that varied as a result of both stimulation and structure. He found the hyperactives to be significantly more active in the low stimulation conditions.

According to the underarousal theory, environments or tasks low in stimulation provoke even more hyperactive behavior in the already underaroused hyperactive child. In fact, Pope (1970) has found that the most difficult task for the hyperactive child was simply remaining seated for five minutes. Similarly, teachers report that hyperactive children tend to be most active in group situations requiring them to wait their turn (Zentall, 1974). In fact, at free play or between tasks, hyperactives have not been found to differ significantly in activity level from normals. Zentall (1975) has said, "Tasks which involve visual and movement-produced stimulation (recess, free-time, unstructured play) tend not to produce greater activity, in hyperactives than normals . . . thus, tasks which involve little movement or stimulation (e.g., waiting) appear to produce greater activity in hyperactive children than in normals."

Other evidence for the underarousal theory comes from observations and evidence that hyperactives in a novel situation behave no differently than normals. According to an optimal

stimulation theory, novel environments should be high in stimulation value. Interestingly, one finds that hyperactives habituate to a novel environment more rapidly than normals. Pope (1970) found that hyperactive children in undirected free play exhibited as much quantitative motor activity as controls but the quality of it differed. Hyperactives made contact with a significantly greater number of objects than controls but spent less time with each object. This has prompted many researchers to characterize their behavior as purposeless and not goal directed when it may instead be the unfortunate consequence of a nervous system that is not only underaroused, but habituates more rapidly than normals. Such a situation would drive the hyperactive to seek more stimulation more frequently than normals.

A third bit of evidence for the underarousal theory comes from the sensory deprivation research. Under conditions of sensory deprivation, normals have been found to exhibit many of the same behaviors as hyperactives--restlessness, difficulty concentrating, poor visual-motor and academic performance, and increased motor activity (Zentall, 1975). Zubek (1963) has shown that many of these effects can be reduced by having the subjects engage in motor activity at frequent intervals. In fact, in those sensory deprivation studies where movement was allowed, normals attempted to achieve a homeostatic balance by increasing their activity (Heron, et al., 1956; Sato & Tada, 1970; Sales, 1971). It has been suggested that the motor activity exhibited by hyperactives under low stimulation conditions, such as waiting their turn in line, may function to "reduce the

effects of stimulus deprivation by increasing visual, auditory, kinesthetic and proprioceptive stimulation" (Zentall, 1975).

A fourth bit of evidence supporting the underarousal theory is the effect of sedatives on hyperactives. Consistent with the theory is the fact that barbituates increase the hyperactivity and motor restlessness of these children. It would appear that sedatives reduce the level of stimulation in these already underaroused children-- precipitating renewed activity to bring the nervous system functioning up to an optimum level.

Stimulation Studies

Auditory-Visual. The other major support for the underarousal theory of hyperactivity is the research related to auditory and visual stimulation. In contradiction to the theory that hyperactives are overaroused and need reduced stimuli, Carter & Diaz (1971) found that increasing the amount of auditory or visual background "distractions" did not negatively effect the reading comprehension of brain-injured children. Whether the population is normal I.Q. hyperactives (Rost & Charles, 1967; Shores & Haubrich, 1969; Campbell & Morgenstern, 1971); Carter & Diaz, 1971) or hyperactive retardates (Cromwell et. al., 1963; Cruse, 1961), the research suggests no detrimental effect of visual "distractors"--whether that be in the form of colored lights and bright pictures on a wall or a slight puzzle background on the test page. The results have been remarkably consistent in noting no impairment for hyperactives as a result of visual stimulation.

Combinations of auditory-visual stimulation have been tried as well (Carter & Diaz, 1971; Zentall & Zentall, 1976; Scott, 1970; and Forehand & Baumeister, 1970). All of these studies have found that

combined auditory and visual stimulation consistently reduces motor activity, and in one study, even improved the arithmetic scores in hyperactives.

Auditory stimulation. Few studies have researched auditory stimulation alone with hyperactives. While Spraudlin & Cromwell (1969) found no significant differences in activity level in hyperactive retardates, experimental controls were poor in the study. Their high auditory stimulation was simply listening to a taped voice for 3 1/2 minutes with no measurement of the sound decibel level. The low auditory stimulation condition was a no-tape condition. Reardon & Bell (1970) studied the effects of stimulative, sedative, and no music on retarded and hyperactive boys and found a significant decrease in activity level with music than without. Furthermore, they found lower activity level during the stimulative than sedative music--results that would support the underarousal theory. Although the study by Scott (1970) could be considered a combination of auditory-visual since it used music in both a normal classroom setting and a reduced stimulation booth--his emphasis clearly was on the auditory stimulation. Though his study was limited by his small sample size (4), his study was nevertheless suggestive that enhanced stimulation could be beneficial to cognitive as well as behavioral performance. Three of the four children functioned best in a normal classroom setting with music playing and showed marked improvement on an arithmetic exercise.

Variables of auditory stimulation. The research on auditory stimulation with hyperactives is scant (Spraudlin & Cromwell, 1969; Reardon & Bell, 1970; Scott, 1970) and poorly controlled. There has

been little attention paid to controlling for such things as loudness or trying to tease out the operative characteristics of the music such as the effect of tempo. That tempo might be an important operative was suggested by Gaston (1968) who stated, "Rhythm is the organizer and the energizer in music." According to Radocy & Boyle (1970), rhythm is composed of melody, meter, tempo and beat. The last three terms have frequently been used interchangeably, and for the purpose of our study have been subsumed under the term "tempo."

It has long been anecdotally accepted that music has differential effects on man. Much of the music research in this area over the last 40 years has been done on the differential effects of "sedative and stimulative" music on man, particularly on mood. Although much of the research is lacking in appropriate statistical methodology, the research has consistently pointed to the fact that people are able to broadly categorize music into stimulative and sedative categories as well as mood reactions to it (Schoen & Gatewood, 1927; Heinlein, 1928; Hevner, 1935; Farnsworth, 1954; Sopchak, 1955).

Numerous researchers have noted tempo and intensity to be critical factors. Radocy & Boyle (1979) note that "Music which stimulates or arouses listeners has a strong energizing component . . . for most people it is rhythm that provides the energy of music, be it great or small. Lundlin (1967) and Farnsworth (1969) both suggest that tempo, an important attribute of rhythm, is of primary importance in influencing mood response to music While rhythm, and particularly tempo, appears to be the predominant energizing factor, dynamic level also appears to serve as a stimulator. Louder music seems to stimulate greater response activity

than softer music." They go on to note that sedative music appears to be differentiated from stimulative music by a generally slower tempo and minimum of rhythmic activity. They state that "apparently individuals concerned with using music for functional purposes have long recognized the differential response to the two types of music, but they have not gone to great lengths to corroborate the effects through research The bulk of the limited research particularly focused on comparisons of responses to the two types of music (stimulative & sedative) was conducted in the 1940's and 1950's . . . nearly all studies found significant differences in response to the two types of music . . . several studies of physiological response to stimulative and sedative music also revealed significant differences in response rates" (Radocy & Boyle, 1979).

The commercial use of music has recognized the potential value of music as an arousal device. In industry, background music has been used for workers engaged in simple repetitive tasks to break the monotony. In vigilance tasks it has been used to maintain alertness due to its "arousal" potentials. Commercials have used music to aid in "facilitating interest in and memory of products" (Radocy & Boyle, 1979).

The research in this century strongly suggests that music can be used as an arousal and facilitating mechanism. The possibility of achieving significant and beneficial response as a result of increasing the arousal level in underaroused hyperactives has not been fully explored.

Although amphetamines are currently the treatment of choice for hyperactivity, their side effects--particularly the possibility of

growth suppression--cause considerable concern. There appeared to be sufficient evidence that increasing environmental stimulation might have beneficial effects on hyperactive children to warrant the present study.

CHAPTER 2

Statement of the Problem

There is evidence to suggest that hyperactive children suffer from an "arousal deficit" of the central nervous system. It has been surmised that their hyperactive behaviors are due to their attempt to increase stimulation. Although drug therapy is currently the treatment of choice in hyperactivity, it has side effects that concern many physicians and parents. A possible alternative to drug therapy could be the manipulation of environmental stimulation. Increasing environmental stimulation could presumably bring them closer to an optimal level of stimulation, and in fact, there are a number of studies using auditory, visual, and combinations of the two types of stimulation that have been shown to significantly reduce their hyperactive behavior. Research showing cognitive improvements has been less frequent, but a few studies (Scott, 1970; Carter & Diaz, 1971) have suggested that even academic skills improve for hyperactives with stimulation. Visual stimulation has been more widely researched, nevertheless, auditory stimulation has been shown to be beneficial as well (Scott, 1970; Carter & Diaz, 1971; Forehand & Baumeister, 1970; Spradlin & Cromwell, 1969; Reardon & Bell, 1970).

The purpose of the present study has been to test the general hypothesis that auditory stimulation in the form of music and specific

variables of music can produce beneficial results in hyperactive children. Six specific hypotheses were tested:

- (1) Scores on cognitive tasks performed during a music treatment condition would be higher than those performed during a non-music condition.
- (2) Behavioral ratings of hyperactive behaviors exhibited would be lower during a musical treatment condition than during a non-music one.
- (3) Scores on cognitive tasks performed under fast tempo conditions would be higher than those performed under slow tempo conditions.
- (4) Behavioral ratings of hyperactive behaviors exhibited would be lower under fast tempo conditions than those performed under slow tempo conditions.
- (5) Scores on cognitive tasks performed under high intensity conditions would be higher than those performed under low intensity conditions.
- (6) Behavioral ratings of hyperactive behaviors exhibited would be lower under high intensity than low intensity music conditions.

CHAPTER 3

Method

Subjects

School administrators, teachers, and school psychologists were contacted in a local school district and asked to identify potentially hyperactive males between the ages of 6 and 14. This population was then subjected to further screening by having the teachers fill out the Davids (1971) Hyperactivity Rating Scale. Thirty-two such children were obtained with a median age of 9.4. All were average (85) or above average IQ as identified in school records. Davids (1971) had suggested that a cut-off score of 24 would identify hyperactives. This cut-off score was used. All children had a score of 24 or higher--indicating they were hyperactive. These school children were obtained from eight elementary schools and one junior high school, providing a wide cross section of the ages and schools.

Ninety-five percent of the subjects were also enrolled in the school system's "resource program" for the behaviorally disordered and learning disabled. Some researchers (Safer & Allan, 1976) have reported that hyperactivity as a subgroup represents generally 39% of the learning disabled children. Since such a substantial proportion of the resource population has been found to be hyperactive and these subjects were enrolled in resource, it seems there is some concurrent

validity with the hyperactivity rating scores of these subjects. It is believed that their high ratings on the hyperactivity rating scale and enrollment in the resource program was evidence that they were indeed hyperactive.

Children who were currently on stimulant medication were excluded from the study since the medication would have introduced an uncontrolled variable in the sample. In addition, it was felt that stimulant medication might confound the treatment effect.

Rating Scale

The Davids Hyperactive Rating Scale (1971) is a refinement of the Connors (1969) Hyperactivity Rating Scale. The Connors has been extensively used and validated in hyperactivity research (Connors, 1970; Werry, Sprague & Cohen, 1975; Werry & Hawthorne, 1976). Rutter (1983) notes that retest reliability for the Connors is high. As an example, a study by Campbell, Schleifer and Weiss (1978) found a .67 correlation between preschool hyperactivity at 4 1/2 years and the hyperactivity score on the Connors at 6 1/2. Studies have also shown a high degree of inter-rater reliability for the Connors. Goyette, Connors and Ulrich (1978) found agreement between mothers and fathers on the scale to be .55. Agreement among child care workers in a study by Stevens, Kupst, Suran, and Schullman (1978) ranged from .58 to .73.

The Davids has slightly fewer behavioral items but contains the same item clusters as the Connors. In addition, it has more extensive descriptions of the items, with a six, rather than a four-point scale on each item. Two studies (Davids, 1971; Denhoff, Davids & Hawkins, 1971) reported adequate reliability. Since the Davids contains the same item clusters as the Connors and even more extensive description

of the behavioral items, it was thought to be a valid and acceptable measure of hyperactivity. The scale descriptions are quite simple and easy to understand. Scores on the instrument range from 0 to 32 with a score of 24 considered to be hyperactive. For the purposes of our study, only children with scores of 24 or higher were used. Over half of the children used in the present study scored over 30 on this scale--in the extremely hyperactive range.

Apparatus and Treatment Conditions

The treatment music was pre-recorded onto four cassette tapes. A sound-level meter (General Radio Type 1565-A) was used to obtain the required decibel levels when the subject was seven feet away from the music source. The fast music selection was from the soundtrack, "Footloose" with an average metronome marking of 156. The slow music selection was from the album "Gate of Dreams" by the Claus Ogerman Orchestra. Selections were: Time Passed Autumn I and Air Antique (average mm 52). Intensity was based on the normal decibel (db) range of speech 30 to 75 db (Radocy & Boyle, 1979). The high intensity condition was set near the upper range at an average of 68 db, while the low intensity condition was set at an average of 50 db--similar to that of background music. Thus, the music treatment conditions were fast tempo-high intensity (156mm, 68db); fast tempo-low intensity (156 mm, 50 db); slow tempo-low intensity (52mm, 50db) and slow tempo-high intensity (52mm, 68db). In addition to receiving one of these four music conditions, each subject also received a "no music" condition--performing comparable tasks without the music playing.

Measures

The dependant variables were measures of both cognitive and behavioral performance taken during both the music and no-music conditions. Behavioral measures were ratings of 1) out of seat behavior and 2) the number of times off task for more than five seconds. Cognitive measures consisted of the subtests making up the "Freedom from Distractability" component of the WISC-R--digit span, arithmetic, and coding (Sattler, 1982). These subtests have been shown to be particularly vulnerable to hyperactivity. Two forms of these tests were used. Form A was the exact items used on the WISC-R and Form B was an alternative form using the same symbols re-arranged for coding, comparable arithmetic problems for arithmetic and only the numbers was changed for digit span. Comparability of forms was tested prior to the data collection. Order of forms was randomly assigned to subjects.

Procedure

An independent rater was trained to judge the behavioral performance--times off-task and out-of-seat behavior prior to the study. The rater was kept blind as to the purposes and specific treatment conditions of the study and was trained to accurately identify the appropriate behaviors 100% of the time. The behavioral rating was dropped after the first quarter of the study, however, when it became apparent that all children were attending well to the tasks and exhibiting no out-of-seat behavior in both music and non-music conditions.

Subjects were taken to the experimental room (a school psychologist's office). They were told, "You will be taking two sets

of tests consisting of some interesting number problems, memory problems, and copying problems. Many children besides yourself will be doing this. There will be another person working in the room, but that will be okay. After the first set of tests we will take a short break and then finish the last set of tests. Just work as quickly and as accurately as you can." The total length of time for the set of three cognitive tasks (arithmetic, coding, digit span) was 15 to 20 minutes.

After the first set of cognitive tasks, the subject was told, "Let's take a break for a few minutes and get a drink of water." The subject and experimenter then both left the room and returned within five minutes. While they were gone, the rater had been instructed ahead of time to either turn the music off that had been playing or turn it on if it had not been playing. The cassette player was located by the rater and he appeared to be listening to it.

Two questions were examined: (1) Is there a significant difference in the cognitive and behavioral performance of hyperactive children between a music and non-music condition? and (2) Are there any significant differences in the cognitive and behavioral performance under the specific musical variables of tempo and intensity? The specific music condition that each subject received was pre-determined before the experiment began, as well as the order of music/no-music presentation. Each subject received one of four treatment conditions: music that was fast tempo-high intensity; fast tempo-low intensity; slow tempo-high intensity or slow tempo-low intensity. Randomization of subject to treatment conditions, order of

music-no music, and order of form (WISC-R or alternate) was done prior to the study.

Based on the underarousal theory as an explanation for hyperactivity, it was hypothesized that:

- (1) Scores on the cognitive tasks performed during a music treatment condition would be higher than those performed during a no-music condition.
- (2) Behavioral ratings of hyperactive behaviors exhibited would be lower during a music treatment condition than a no-music condition.
- (3) Scores on cognitive tasks performed under fast tempo conditions would be higher than those performed under slow tempo conditions.
- (4) Behavioral ratings of hyperactive behaviors exhibited would be lower under fast tempo conditions than those performed under slow tempo conditions.
- (5) Scores on cognitive tasks performed under high intensity conditions would be higher than those performed under low intensity conditions.
- (6) Behavioral ratings of hyperactive behaviors would be lower under high intensity than low intensity music conditions.

Statistics

The experimental design was a Greco-Latin Square nested in a two-by-two-by-two factorial (see Figure 1). Randomization was done of subjects to treatment conditions, of the order of the forms of tests taken (A, B or B, A) and finally the order of the music and no-music

conditions that each subject receives. An analysis of variance was used to analyze the data.

LOUDNESS (L)

		High	Low
Fast	A Music	B No	
	B Music	A No	
	A No	B Music	
	B No	A Music	
Slow			

TEMPO (T)

Figure 1. Experimental design.

CHAPTER 4

Results

An analysis of variance was performed on the data to test for significant differences in main effects and interactions (See Tables 1-3). The data was analyzed by both raw scores and standard scores to control for age differences (Table 4). The analyses revealed only one test that was significant at the .05 level. A tempo-loudness-order (TLO) interaction was significant at .049 for Digit Span (standard scores). However, it was determined that this was probably due to chance. Examination of the means of this interaction showed no clear pattern suggesting this was probably a chance occurrence. All other tests performed on the data failed to meet the significance level of .05. Subgrouping of subjects were examined in a posthoc analysis but no significant differences were noted.

Correlations between changes on the dependant measures and the variables of age and hyperactivity rating scores were performed (Table 5) to examine the possibility of certain ages or higher ratings showing more change. These correlations were non-significant except for a negative correlation between arithmetic and coding that was significant at the .05 level. This suggested that there was no significant relationship between age or hyperactivity rating scores and either improvement or impairment on the cognitive measures. It would seem that change scores on arithmetic were inversely related to change scores on digit span.

Table 1

Analysis of Variance Digit Span (Standard Scores)

Variables	df	SS	MS	F	P Level
Between Treatments					
Tempo (T)	1	2.2500	2.2500	0.2737	0.608
Loudness (L)	1	2.2500	2.2500	0.2737	0.608
TL	1	1.0000	1.0000	0.1216	0.732
Between Groups					
Group (G)	3	1.6250	0.5417	0.0659	0.977
TG	3	12.1250	4.0417	0.4917	0.693
LG	3	27.8750	9.2917	1.1305	0.366
TLG	3	80.3750	26.7917	3.2598	0.049
Between Subjects					
Subj (S)	16	131.5000	8.2188	3.4244	0.005
Within Subjects					
Order (O)	1	0.6250	0.6250	0.0260	0.873
TO	1	3.0625	3.0625	1.2760	0.272
LO	1	1.5625	1.5625	0.6510	0.429
TLO	1	1.5625	1.5625	0.6514	0.429
Music (M)	1	0.0625	0.0625	0.0260	0.873
TM	1	1.5625	1.5625	0.6510	0.429
LM	1	0.5625	0.5625	0.2343	0.634
TLM	1	0.0625	0.0625	0.0260	0.873
Form (F)	1	1.0000	1.0000	0.4166	0.526

(continued)

Table 1 (continued)

Variables	df	SS	MS	F	P Level
TF	1	0.2500	0.2500	0.1041	0.750
LF	1	6.2500	6.2500	2.6041	0.122
TLF	1	0.0000	0.0000	0.0000	---

Table 2
Analysis of Variance Arithmetic (Standard Scores)

Variables	df	SS	MS	F	P Level
Between Treatments					
Tempo (T)	1	4.5156	4.5156	0.3144	0.583
Loudness (L)	1	2.6406	2.6406	0.1838	0.674
TL	1	0.1563	0.1563	0.0010	0.974
Between Groups					
Group (G)	3	12.0469	4.0156	0.2796	0.839
TG	3	69.9218	69.9218	1.6231	0.223
LG	3	69.7969	23.2656	1.6202	0.224
TLG	3	15.1719	5.0573	0.3521	0.788
Between Subjects					
Subj (S)	16	229.7500	14.3593	4.7420	0.001
Within Subjects					
Order (O)	1	0.3906	0.3906	0.1289	0.723
T0	1	0.0156	0.0156	0.0051	0.943
L0	1	1.2656	1.2656	0.4179	0.525
TLO	1	0.3906	0.3906	0.1289	0.723
Music (M)	1	1.8906	1.8906	0.6243	0.439
TM	1	1.2656	1.2656	0.4179	0.525
LM	1	0.3906	0.3906	0.1289	0.723
TLM	1	0.7656	0.7656	0.2528	0.621
Form (F)	1	0.7656	0.7656	0.2528	0.621

(continued)

Table 2 (continued)

Variables	df	SS	MS	F	P Level
TF	1	8.2656	8.2656	2.7296	0.114
LF	1	0.0156	0.0156	0.0051	0.943
TLF	1	3.5156	3.5156	1.1609	0.294

Table 3
Analysis of Variance Coding (Standard Scores)

Variables	df	SS	MS	F	P Level
Between Treatments					
Tempo (T)	1	3.5156	3.5156	0.2136	0.650
Loudness (L)	1	9.7656	9.7656	0.5935	0.452
TL	1	0.7656	0.7656	0.0465	0.832
Between Groups					
Group (G)	3	22.6718	7.3372	0.4593	0.715
TG	3	86.9218	28.9739	1.7610	0.195
LG	3	85.6718	28.5572	1.7356	0.200
TLG	3	50.1718	16.7239	1.0164	0.411
Between Subjects					
Subj (S)	16	263.2500	16.4531	8.9388	0.000
Within Subjects					
Order (O)	1	0.7656	0.7656	0.4159	0.526
TO	1	4.5156	4.5156	2.4531	0.133
LO	1	3.5162	3.5162	1.9100	0.182
TLO	1	3.5162	3.5162	1.9100	0.182
Music (M)	1	4.5156	4.5156	2.4533	0.133
TM	1	1.2656	1.2656	0.6876	0.417
LM	1	2.6406	2.6406	1.4346	0.245
TLM	1	1.8906	1.8906	1.0271	0.323
Form (F)	1	1.8906	1.8906	1.0271	0.323

(continued)

Table 3 (continued)

Variables	df	SS	MS	F	P Level
TF	1	2.6406	2.6406	1.4346	0.245
LF	1	1.8906	1.8906	1.0271	0.323
TLF	1	2.6406	2.6406	1.4346	0.245

Table 4

Raw and Standard Scores on Cognitive Measures

SN	HRS	MC+	Music				Nonmusic				Cod*					
			Arith	Arith*	DS	DS*	Cod	Cod*	Arith	Arith*		DS	DS*	Cod	Cod*	
1	31	1,2	7	7	6	6	21	6	21	6	6	7	7	6	26	8
2	31	1,2	7	4	8	6	56	6	56	14	7	8	8	7	51	12
3	30	1,2	12	10	15	13	46	13	46	11	11	13	11	15	45	11
4	33	2,1	10	14	8	9	20	8	20	4	4	10	14	7	23	5
5	33	2,1	10	11	8	8	20	8	20	5	5	8	7	7	28	8
6	36	2,1	6	6	5	6	20	6	20	4	4	7	8	5	16	3
7	34	2,1	10	7	7	5	27	5	27	5	5	9	6	4	35	8
8	25	2,1	8	12	7	9	18	9	18	5	5	8	12	2	24	7
9	37	1,2	12	11	9	8	31	8	31	7	7	12	11	5	43	12
10	30	2,1	8	4	7	4	55	4	55	12	12	13	9	6	60	13
11	29	2,1	9	6	7	5	42	5	42	10	10	12	10	5	39	9
12	30	1,2	4	3	7	7	24	5	24	7	7	4	3	8	21	6
13	29	1,2	15	11	9	9	35	9	35	5	5	15	11	8	34	4
14	25	2,1	15	10	7	7	56	7	56	15	15	11	9	5	50	13
15	27	1,2	12	5	7	7	36	7	36	6	6	11	7	7	46	9
16	36	1,2	9	6	6	6	60	6	60	11	11	12	8	6	51	9
17	35	2,1	10	11	7	7	72	7	72	13	13	16	12	6	65	12
18	32	1,2	15	8	6	6	31	6	31	7	7	11	9	10	32	7
19	25	1,2	10	8	11	11	35	11	35	9	9	10	9	8	33	9
20	25	1,2	9	5	5	5	43	5	43	6	6	11	6	7	51	8
21	35	2,1	10	10	9	9	54	9	54	17	17	10	10	8	46	15
22	31	1,2	10	7	12	12	31	12	31	10	10	10	8	9	20	5

(continued)

Table 4 (continued)

SN	HRS	MC+	Music						Nonmusic					
			Arith	Arith*	DS	DS*	Cod	Cod*	Arith	Arith*	DS	DS*	Cod	Cod*
23	34	2,1	7	10	9	9	30	7	10	9	5	4	28	6
24	28	1,2	10	10	9	9	33	10	11	10	10	10	35	11
25	28	2,1	9	12	9	10	35	9	6	9	10	10	36	9
26	35	2,1	10	9	11	10	35	9	7	12	11	11	40	11
27	26	2,1	12	12	9	8	35	10	11	6	5	5	33	9
28	30	2,1	8	10	7	8	26	6	7	7	8	8	29	7
29	27	1,2	9	8	7	6	28	7	7	7	6	6	28	7
30	29	2,1	13	14	7	7	26	7	13	7	7	7	27	7
31	31	1,2	8	8	8	8	31	10	8	9	9	9	27	8
32	29	1,2	10	7	9	7	50	12	10	13	11	11	42	9
		x =	9.7	8.6	8.7	7.7	36.3	8.6	9.6	8.2	8.5	7.5	36.3	8.7
		s =	2.4	2.9	2.0	2.1	13.5	3.3	2.9	3.0	2.8	2.5	11.9	2.8

Note: SN = Subject Number; HRS = Hyperactivity Rating Scale; MC = Music Combination

* Indicates Standard Scores

+ Music Combinations: 1,2 = slow tempo, high intensity
 1,1 = slow tempo, low intensity
 2,1 = fast tempo, low intensity
 2,2 = fast tempo, high intensity

Table 5

Correlations of Dependant Measures With Age and HyperactivityRating Scores

Variables	Age	Hyp Score	Arith	Digit Span	Coding
Hyp Score	0.006				
Arith	-0.227	0.020			
D.S.	-0.275	0.049	0.183		
Coding	0.062	0.124	-0.351*	0.015	

*Significant at $p = .05$.

Two trends in the data were noted. However, they are reported with caution given the levels of significance ($p=.062$, $p=.109$, $p=.107$, $p=.133$). The trend was for the best scores across all the cognitive tasks to be made under the extremes of musical stimulation. That is, subjects produced the highest scores on cognitive tasks when the music was a combination of fast and high in intensity (loudness) or slow and low in intensity. In addition, subjects tended to perform coding tasks better under no-music conditions (.121). Once again, these findings should be viewed with caution.

Since all other tests for significance on the data failed to reach the .05 level the null hypothesis was accepted. It was concluded that

- (1) There was no statistically significant difference on cognitive tasks performed under music and no-music conditions.
- (2) Behavioral ratings of hyperactive behaviors showed no difference between music and no-music conditions.
- (3) There was no difference between scores on cognitive tasks performed under fast or slow tempo conditions.
- (4) There was no difference on behavioral ratings made under fast or slow tempo conditions.
- (5) There was no difference between scores on cognitive tasks performed under high or low intensity music conditions.
- (6) Behavioral ratings of hyperactive behaviors showed no difference between high and low intensity conditions.

Discussion

The present study attempted to improve on much of the research that has been done on the effect of stimulation on hyperactivity.

First, of the studies reviewed, most appeared flawed by small sample size and its concomitant problems. Only one study had a large sample size (Carter & Diaz, 1971). They used 42 "brain injured" and 42 controls selected from a number of school districts. However, the results of their study indicated not that there was a cognitive improvement--only that stimulation resulted in "no decrement." The present study attempted to improve on research in the area by using a larger sample size (32) than most previous studies.

A second improvement of this study was a more stringent selection criteria than used by most previous research in this area. Of the best studies reviewed, only two studies selected subjects on the basis of a hyperactivity rating scale. Zentall & Zentall (1976) used the Connors Hyperactivity Rating Scale and Zentall (1980) used the Davids Rating Scale for subject selection. The other studies selected subjects on such variable criteria as "physician diagnosed hyperactivity" (Carter & Diaz, 1971), hyperactivity defined as activity level measured by a "ballistograph" (Gardner & Cromwell, 1959), an ultrasonic motion recorder (Forehand & Baumeister, 1970) or subjects simply judged to be hyperactive without any formal measurement (Scott, 1970).

A third and final improvement was the testing of specific variable of the auditory stimulation that might be "active ingredients." Only one of the studies reviewed (Reardon & Bell, 1970) examined specific music factors and those were loosely defined as "sedative or stimulative music." Stimulative music was "rock & roll" without a specific tempo and sedative was a "Bach chorale." The music level was given as 80 db, but the distance from the subject was

unspecified. It is believed that our study more precisely defined such ingredients as tempo (slow=52 mm, fast=156 mm) and intensity (high=68 db, low=50 db).

It was thought that all these refinements would greatly improve the quality of the research that had been done in this area and more adequately test the under-stimulation theory of hyperactivity. Since the findings failed to show significant differences in music/no-music conditions or the specific variables of tempo and intensity, several explanations must be considered including questioning the adequacy of the understimulation theory itself.

There are several factors that could be potential explanations for the lack of significant differences--factors that must be taken into account in future research in the area:

First, it could be argued that the experiment was experienced as a novel situation by taking the child away from the usual classroom routine. If that is the case, the underarousal theory would postulate that the child could be optimally "aroused" by the novel experimental situation. If the subject were already optimally aroused in the experimental situation, no differences should be manifest then between music and no-music conditions. In fact, several researchers (Stewart, 1970 and Sleator & Ulman, 1981) have found that "hyperactives were not behaviorally distinctive in novel settings" (Rutter, 1983). This novelty effect was not controlled for in the present study. However, only one study reviewed (Scott, 1970) used experimental manipulations in the classroom itself. That study was only quasi-experimental, consisting of only four subjects.

The present study has been limited by the amount of "intrusion" the school system was willing to permit. Although performing the experiment in the classroom to reduce the novelty effect would have been the ideal situation--taking the child to an experimental room for a short period of time was all the school system was willing to accept. Since almost all previous studies (Carter & Diaz, 1971; Zentall & Zentall, 1976; Gardner & Cromwell, 1959; Forehand & Baumeister, 1970; Reardon & Bell, 1970) had been performed in an experimental room and many had found significant differences, the novelty effect is tendered as a possible but not probable explanation for the lack of significant findings. Future research to rule out this possibility is likely to be limited, as the present one was, by the cooperation of the school systems.

A second potential problem of this study could be argued to be the restriction of range. It is possible that by restricting the population to only hyperactives, it made it more difficult to detect significant differences. Adding normals to the study, even if necessary, would have been quite difficult. Parents and school officials are used to granting permission to test hyperactive children but obtaining permission to test "normal" children would have been much more difficult. However, only two of the studies examined (Carter & Diaz, 1971; Zentall, 1980) used a population of hyperactives and controls. Most other studies used hyperactives alone and yet found significant results.

A third possible problem was the length of the treatment condition. In the present study the music condition lasted 15 to 20 minutes. It could be argued that this was not long enough to make

significant differences in arousal level. However, previous studies had shown significant treatment effects with treatment times as little as five minutes (Gardner & Cromwell, 1959) or as long as an hour (Reardon & Bell, 1970). The present treatment length was believed to be adequate based on previous research.

The last consideration is whether or not the population was actually "hyperactive." As has been previously noted, the behavioral ratings were dropped early in the study because the children were on task and in seat. Later in the study children showed the same behavior. The rating scale used to identify them was the Davids--essentially a version of the Connors which has been used and validated extensively in hyperactive research. The subjects used were those scoring well within the hyperactive range according to this scale. Most previous studies have used either the Connors or the Davids scale. Although it was unexpected that they would attend well to the task, a number of researchers (Whalen, et al., 1978; Whalen, Henker, Collins, Finck & Dotemoto, 1979) have noted the situational variability of hyperactivity. They have found that hyperactivity is most obvious in the classroom at times when the children are expected to be engaged in formal work. Hyperactivity is least evident in novel settings. This could explain why Sleator and Ulman (1981) found that hyperactivity in the pediatrician's office was not a particularly good predictor. It could be that the experimental room was like the "pediatrician's office"--of sufficient novelty to reduce at least the behavioral aspects of the hyperactivity in and of itself. Even though they did not act like hyperactives in this setting, nevertheless, it is believed that they were truly hyperactives. One way to determine

this in the future would be to do the study in the classroom or a setting that has been found to provoke hyperactivity more readily.

The potential problems of the present study can be enumerated--the possibility of a novelty effect, restriction of range, length of treatment time and whether or not the population was actually "hyperactive." Recommendations for future research would be to perform the experiment in an actual classroom setting that included both hyperactive children and non-hyperactive children. Treatment time could be extended to 30 minutes instead of the present 15 to 20 minutes. However, the feasibility of performing such an improved experiment would greatly depend on the cooperation of the school system.

Even if such an improved experiment is done and these variables controlled for, it is very possible that no significant differences will be found. All the potential problems of the present study have been remedied in parts of previous research--Gardner & Cromwell (1959) had a larger sample size but poorly defined hyperactivity criteria; Carter & Diaz (1971) had hyperactives and controls but had poorly defined subject selection criteria; Reardon & Bell (1970) had treatment times of one hour but listened to music subjectively defined as stimulative and sedative--but each of these studies appeared flawed in some way.

The present seems most flawed by the use of an experimental room instead of a classroom setting, possibly creating a novelty effect. Nevertheless, it has attempted to remedy the weak areas noted in the stimulation studies in the area. Despite their reports of significant findings, when more stringent methodology is applied, significant

studies--significant differences are not there! It is felt that the understimulation theory as an explanation for hyperactivity is not supported in the present study. Future research is needed.

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